June 2007

Marine Science Review – 219

Human health

SeaWeb
Leading Voices for a Healthy Ocean

In this review:

A. Recent articles – no abstract available

Cabello, F.C., Espejo, R.T., Hernandez, M.C., Rioseco, M.L., Ulloa, J., and Vergara, J.A. ***Vibrio parahaemolyticus* O3:K6 epidemic diarrhea, Chile, 2005.** *Emerging Infectious Diseases* 13(4): 655-656, 2007.

Luoma, S.N. and Lofstedt, R.E. **Contaminated salmon and the public's trust.** *Environmental Science and Technology* 41(6): 1811-1814, 2007.

B. Recent articles with abstracts

Wigle, D.T., Arbuckle, T.E., Walker, M., Wade, M.G., Liu, S.L., and Krewski, D. **Environmental hazards: Evidence for effects on child health.** *Journal of Toxicology and Environmental Health Part B* 10(1-2): 3-39, 2007.

Notes: The human fetus, child, and adult may experience adverse health outcomes from parental or childhood exposures to environmental toxicants. The fetus and infant are especially vulnerable to toxicants that disrupt developmental processes during relatively narrow time windows. This review summarizes knowledge of associations between child health and development outcomes and environmental exposures, including lead, methylmercury, polychlorinated biphenyls (PCBs), dioxins and related polyhalogenated aromatic hydrocarbons (PHAHs), certain pesticides, environmental tobacco smoke (ETS), aeroallergens, ambient air toxicants (especially particulate matter [PM] and ozone), chlorination disinfection by-products (DBPs), sunlight, power-frequency magnetic fields, radiofrequency (RF) radiation, residential proximity to hazardous waste disposal sites, and solvents. The adverse health effects linked to such exposures include fetal death, birth defects, being small for gestational age (SGA), preterm birth, clinically overt cognitive, neurologic, and behavioral abnormalities, subtle neuropsychologic deficits, childhood cancer, asthma, other respiratory diseases, and acute poisoning. Some environmental toxicants, notably lead, ionizing radiation, ETS, and certain ambient air toxicants, produce adverse health effects at relatively low exposure levels during fetal or child developmental time windows. For the many associations supported by limited or inadequate epidemiologic evidence, major sources of uncertainty include the limited number of studies conducted on specific exposure-outcome relationships and methodologic limitations. The latter include (1) crude exposure indices, (2) limited range of exposure levels, (3) small sample sizes, and (4) limited knowledge and control of potential confounders. Important knowledge gaps include the role of preconceptual paternal exposures, a topic much less studied than maternal or childhood exposures. Large longitudinal studies beginning before or during early pregnancy are urgently needed to accurately measure and assess the relative importance of parental and childhood exposures and evaluate relatively subtle health outcomes such as neuropsychologic and other functional deficits. Large case-control studies are also needed to assess the role of environmental exposures and their interactions with genetic factors in relatively uncommon outcomes such as specific types of birth defects and childhood cancers. There is also an urgent need to accelerate development and use of biomarkers of exposure and genetic susceptibility in epidemiologic studies. This review supports the priority assigned by international agencies to relationships between child health and air quality (indoor and outdoor), lead, pesticides, water contaminants, and ETS. To adequately address such priorities, governments and agencies must strengthen environmental health research capacities and adopt policies to reduce parental and childhood exposures to proven and emerging environmental threats.

Hayward, D., Wong, J., and Krynitsky, A.J. **Polybrominated diphenyl ethers and polychlorinated biphenyls in commercially wild caught and farm-raised fish fillets in the United States.** *Environmental Research* 103(1): 46-54, 2007.

Notes: Wild caught and farm-raised fish fillets collected in fish markets and large-chain super markets located in the Maryland, Washington, DC, and North Carolina were measured for their polybrominated diphenyl ether (PBDE), polychlorinated biphenyl (PCB), and polychlorodibenzo-p-dioxins/dibenzofurans (PCDD/Fs) levels. PCB and PBDE concentrations were the highest in a wild bluefish fillet (800 and 38 ng/g wet weight, respectively) and the lowest in wild Coho salmon fillet (0.35 and 0.04 ng/g, respectively). Levels for both PCBs and PBDEs in ng/g wet weight decreased from bluefish with medians of 200 and 6.2, to rockfish 66 and 4.7, followed by farmed-raised salmon with 9.0 and 1.1, with the lowest in wild salmon, 4.0 and 0.3 ng/g for PCBs and PBDEs, respectively (PCBs are the sum of 25 congeners). The chlorinated biphenyl (CB)-153 and brominated diphenyl ether (BDE)-47 levels correlated in the 22 fish fillets with a Pearson correlation coefficient of 0.94. Bluefish, rockfish (striped bass), wild caught and farm-raised salmons all showed different linear regression slopes between CB-153 and BDE-47 of 7.5, 2.7, 0.97, and 1.5, respectively. A Wilcoxon rank sum test showed no significant difference in the CB-153/BDE-47 ratios between farmed raised and all species of wild salmon combined, but was significant between bluefish and rockfish, farmed raised salmon or wild salmon.

Hansman, G.S. and et al. **Human sapovirus in clams, Japan.** *Emerging Infectious Diseases* 13(4): 620-622, 2007.

Notes: Human sapovirus was detected in 4 of 57 clam packages by reverse transcription-PCR and sequence analysis. This represents the first finding of sapovirus contamination in food. Closely matching sequences have been detected in stool specimens from patients with gastroenteritis in Japan, which indicates a possible food-to-human transmission link.

Llobet, J.M., Falco, G., Bocio, A., and Domingo, J.L. **Human exposure to polychlorinated naphthalenes through the consumption of edible marine species.** *Chemosphere* 66(6): 1107-1113, 2007.

Notes: The concentrations of polychlorinated naphthalenes (PCNs) were determined in samples of 14 edible marine species (sardine, tuna, anchovy, mackerel, swordfish, salmon, hake, red mullet, sole, cuttlefish, squid, clam, mussel and shrimp), which are widely consumed by the population of Catalonia, Spain. The daily intake of PCNs associated with this consumption was also determined. A total of 42 composite samples were analyzed by HRGC/HRMS. The highest PCN levels (ng/kg of fresh weight) were found in salmon (227) followed by mackerel (95) and red mullet (68), while the lowest levels of total PCNs corresponded to shrimp (4.9) and cuttlefish (2.7). With the exception of cephalopods and shellfish species, in which tetra-CN was the predominant homologue, penta-CN (60%) was the predominant contributor to total PCNs. For a standard male adult, PCN intake through the consumption of edible marine species was 1.53 ng/day. The highest contributions to this intake (ng/day) corresponded to salmon (0.41), sole (0.28) and tuna (0.24). Concerning health risks, species-specific TEFs such as those reported by WHO and NATO for PCDD/ Fs and dioxin-like PCBs are not currently available for PCN congeners. Although in general terms the results of the present study do not seem to suggest specific risks derived from exposure to PCNs through fish and seafood consumption, to establish the contribution of individual PCN congeners to total TEQ is clearly necessary for the assessment of human health risks.

Virtanen, J.K., Rissanen, T.H., Voutilainen, S., and Tuomainen, T.P. **Mercury as a risk factor for cardiovascular diseases.** *Journal of Nutritional Biochemistry* 18(2): 75-85, 2007.

Notes: Mercury is a heavy metal that exists naturally in the environment. Major sources include the burning of fossil fuels (especially coal) and municipal waste incineration. Mercury can exist in several forms, with the most hazardous being organic methylmercury. In waterways (lakes, rivers, reservoirs, etc.), mercury is converted to methylmercury, which then accumulates in fish, especially in large predatory fish. Fish and fish products are the major - if not the only - source of methylmercury in humans. Mercury has long been recognized as a neurotoxin for humans, but in the last 10 years, its potentially harmful effects on cardiovascular diseases (CVD) have raised a cause for concern, mostly due to the proposed role of mercury in oxidative stress propagation. Some epidemiological studies have indeed found an association between increased levels of mercury in the

body and risk of CVD. There are several plausible mechanisms to explain the association; these are discussed in this review. We also review the epidemiological studies that have investigated the association between mercury and CVD.

Elmir, S.M., Wright, M.E., Abdelzaher, A., Solo-Gabriele, H.M., Fleming, L.E., Miller, G., Rybolowik, M., Shih, M.T.P., Pillai, S.P., Cooper, J.A., and Quaye, E.A. **Quantitative evaluation of bacteria released by bathers in a marine water.** *Water Research* 41(1): 3-10, 2007.

Notes: *Enterococci*, a common fecal indicator, and *Staphylococcus aureus*, a common skin pathogen, can be shed by bathers affecting the quality of recreational waters and resulting in possible human health impacts. Due to limited information available concerning human shedding of these microbes, this study focused on estimating the amounts of *enterococci* and *S. aureus* shed by bathers directly off their skin and indirectly via sand adhered to skin. Two sets of experiments were conducted at a marine beach located in Miami-Dade County, Florida. The first study, referred to as the "large pool" study, involved 10 volunteers who immersed their bodies in 4700 L during four 15 min cycles with exposure to beach sand in cycles 3 and 4. The "small pool" study involved 10 volunteers who were exposed to beach sand for 30 min before they individually entered a small tub. After each individual was rinsed with offshore marine water, sand and rinse water were collected and analyzed for *enterococci*. Results from the "large pool" study showed that bathers shed concentrations of *enterococci* and *S. aureus* on the order of 6 x 105 and 6 x 106 colony forming units (CFU) per person in the first 15 min exposure period, respectively. Significant reductions in the bacteria shed per bather (50% reductions for *S. aureus* and 40% for *enterococci*) were observed in the subsequent bathing cycles. The "small pool" study results indicated that the enterococci contribution from sand adhered to skin was small (about 2% of the total) in comparison with the amount shed directly from the bodies of the volunteers. Results indicated that bathers transport significant amounts of *enterococci* and *S. aureus* to the water column, and thus human microbial bathing load should be considered as a non-point source when designing recreational water quality models.

Adams, D.H. and McMichael, R.H. **Mercury in king mackerel, *Scomberomorus cavalla*, and Spanish mackerel, *S. maculatus*, from waters of the south-eastern USA: regional and historical trends.** *Marine and Freshwater Research* 58(2): 187-193, 2007.

Notes: Mackerels and other piscivorous marine fishes can contain significant levels of mercury. To monitor and better understand mercury levels in mackerel populations, total mercury concentrations were analysed in dorsal muscle tissue from 279 king mackerel, *Scomberomorus cavalla*, and from 580 Spanish mackerel, *S. maculatus*, collected from offshore and coastal waters of the Atlantic Ocean and Gulf of Mexico in the south-eastern USA. Mercury levels in king mackerel ranged from 0.19 to 3.6 ppm (mean = 0.94 ppm; median = 0.65 ppm) on the Atlantic coast and from 0.18 to 4.0 ppm (mean = 1.51 ppm; median = 1.3 ppm) on the gulf coast. Total mercury levels for Spanish mackerel ranged from 0.04 to 1.3 ppm (mean = 0.32 ppm; median = 0.27 ppm) on the Atlantic coast and from 0.09 to 3.2 ppm (mean = 0.53 ppm; median = 0.44 ppm) on the gulf coast. Data from the present study suggest that Gulf of Mexico king and Spanish mackerel contain significantly higher levels of mercury than those from the Atlantic coast. Total mercury levels and fish length were positively related in both species and in both regions. A positive relationship between total mercury levels and king mackerel age was also detected. No differences in mercury levels were observed between males and females within either species. Comparisons of pre-and post-1996 mercury levels indicated a short-term historical decline in total mercury levels of Spanish mackerel from gulf-coast waters between 1990 and 2002. Further, mercury levels of these species were higher than those recorded in the 1970s.

Tou, J.C., Jaczynski, J., and Chen, Y.C. **Krill for human consumption: Nutritional value and potential health benefits.** *Nutrition Reviews* 65(2): 63-77, 2007.

Notes: The marine crustacean krill (order Euphausiacea) has not been a traditional food in the human diet. Public acceptance of krill for human consumption will depend partly on its nutritive value. The aim of this article is to assess the nutritive value and potential health benefits of krill, an abundant food source with high nutritional value and a variety of compounds relevant to human health. Krill is a rich source of high-quality protein, with the advantage over other animal proteins of being low in fat and a rich source of omega-3 fatty acids. Antioxidant levels in krill are higher than in fish, suggesting benefits against oxidative damage. Finally, the waste generated by the processing of krill into edible products can be developed into value-added products.

Dawczynski, C., Schubert, R., and Jahreis, G. **Amino acids, fatty acids, and dietary fibre in edible seaweed products.** *Food Chemistry* 103(3): 891-899, 2007.

Notes: The nutritional compositions of 34 edible seaweed products of the *Laminaria* sp., *Undaria pinnatifida*, *Hizikia fusiforme* and *Porphyra* sp. varieties were analyzed. This study determined amino acid and fatty acid (FA) distributions and contents of protein, fat, and total fibre of these seaweed varieties. In general, the marine macroalgae varieties tested demonstrated low lipid contents with 2.3 ± 1.6 g/100 g semi-dry sample weight (s.w.) and proved to be a rich source of dietary fibre (46.2 ± 8.0 g/100 g s.w). The pure protein content of seaweed products varied widely (26.6 ± 6.3 g/100 g s.w. in red algae varieties and 12.9 ± 6.2 g/100 g sw. in brown algae varieties). All essential amino acids were detected in the seaweed species tested and red algae species featured uniquely high concentrations of taurine when compared to brown algae varieties. Interestingly, the FA distribution of seaweed products showed high levels of n-3 FA and demonstrated a nutritionally ideal n-6/n-3 FA ratio. The predominante FA in various seaweed products was eicosapentaenoic acid (C20:5, n-3) which was at concentrations as high as 50% of total FA content.

Johnson, L.L., Ylitalo, G.M., Arkoosh, M.R., Kagley, A.N., Stafford, C., Bolton, J.L., Buzitis, J., Anulacion, B.F., and Collier, T.K. **Contaminant exposure in outmigrant juvenile salmon from Pacific Northwest estuaries of the United States.** *Environmental Monitoring and Assessment* 124(1-3): 167-194, 2007.

Notes: To better understand the dynamics of contaminant uptake in outmigrant,juvenile salmon in the Pacific Northwest, concentrations of polychlorinated biphenyls (PCBs), DDTs, polycylic aromatic hydrocarbons (PAHs) and organochlorine pesticides were measured in tissues and prey of juvenile chinook and coho salmon from several estuaries and hatcheries in the US Pacific Northwest. PCBs, DDTs, and PAHs were found in tissues (whole bodies or bile) and stomach contents of chinook and coho salmon sampled from all estuaries, as well as in chinook salmon from hatcheries. Organochlorine pesticides were detected less frequently. Of the two species sampled, chinook salmon had the highest whole body contaminant concentrations, typically 2-5 times higher than coho salmon from the same sites. In comparison to estuarine chinook salmon, body burdens of PCBs and DDTs in hatchery chinook were relatively high, in part because of the high lipid content of the hatchery fish. Concentrations of PCBs were highest in chinook salmon from the Duwamish Estuary, the Columbia River and Yaquina Bay, exceeding the NOAA Fisheries' estimated threshold for adverse health effects of 2400 ng/g lipid. Concentrations of DDTs were especially high in juvenile chinook salmon from the Columbia River and Nisqually Estuary; concentrations of PAH metabolites in bile were highest in chinook salmon from the Duwamish Estuary and Grays Harbor. Juvenile chinook salmon are likely absorbing some contaminants during estuarine residence through their prey, as PCBs, PAHs, and DDTs were consistently present in stomach contents, at concentrations significantly correlated with contaminant body burdens in fish from the same sites.

Rodas-Suarez, O.R., Flores-Pedroche, J.F., Betancourt-Rule, J.M., Quinones-Ramirez, E.I., and Vazquez-Salinas, C. **Occurrence and antibiotic sensitivity of *Listeria monocytogenes* strains isolated from oysters, fish, and estuarine water.** *Applied and Environmental Microbiology* 72(11): 7410-7412, 2006.

Notes: We analyzed the presence of *Listeria* spp. in oyster, fish, and seawater samples and tested isolates for antibiotic sensitivity. *Listeria monocytogenes* was found in 4.5% of fish samples and 8.3% of seawater samples and was not recovered from oysters. Multiresistant environmental strains were found, representing a potential threat to human health.

Imm, P., Knobeloch, L., and Anderson, H.A. **Maternal recall of children's consumption of commercial and sport-caught fish: Findings from a multi-state study.** *Environmental Research* 103(2): 198-204, 2007.

Notes: A randomized telephone survey of 3015 women was conducted in an effort to assess the effectiveness of local sport-fish consumption advisories. Survey participants were between the ages of 18 and 45 and lived in the states of Arkansas, California, Connecticut, Florida, Maine, Minnesota, Montana, New Jersey, New Mexico, North Carolina, and Wisconsin. At

the time of the women's interview, fish and shellfish consumption information was obtained for children under 18 years of age living in the household. One child (aged 2-17) from each household (1852) was randomly selected to evaluate fish consumption among children. Based on maternal recall, 84% of these children had consumed fish or shellfish at least once during the previous 12 months. This percentage ranged from 73% in New Jersey to 94% in Louisiana and was higher among children who lived with a licensed angler compared to those who did not. Eight percent of the children ate fish and/or shellfish more than twice a week. Of the total number of fish and shellfish meals eaten by children, 67% was commercial finfish, 22% was shellfish, and 11% was sport-caught finfish. Among those who ate fish, the average consumption rate was 47 meals per year -- slightly less than one meal per week. This consumption frequency rate varied by state of residence ranging from 37 meals per year in Montana and Wisconsin to 62 in Florida. Because of these regional differences, the use of national average fish consumption rates may over- or under-estimate consumption in localized areas. This survey suggests that targeting information to women who eat fish may also protect children; more than 80% of children have fish consumption patterns that are similar to that of their mothers. Additional research and biomonitoring is needed to improve our understanding of the risk and benefits associated with childhood consumption of fish and shellfish.

Paz, S., Bisharat, N., Paz, E., Kidar, O., and Cohen, D. **Climate change and the emergence of *Vibrio vulnificus* disease in Israel.** *Environmental Research* 103(3): 390-396, 2007.

Notes: In 1996, a major unexplained outbreak of systemic *Vibrio vulnificus* infection erupted among Israeli fish market workers. The origins of this emergent infectious disease have not been fully understood. A possible link between climate change and disease emergence is being investigated. Meteorological service data from 1981, the earliest detection and reporting of *V. vulnificus* for the time in Israel, to 1998 for two stations located within the main inland fish farm industry were analyzed. The 1996-1998 summers were identified as the hottest ever recorded in Israel in the previous 40 years. Time series of monthly minimum, maximum, and mean temperatures showed significant increase in the summer temperatures along the 18 years. The highest minimum temperature value was recorded in summer 1996. Lag correlation analysis revealed significant correlations between temperature values and hospital admission dates. The eruption appeared 25-30 days after the extreme heat conditions in summer 1996, at a lag of 3 weeks in summer 1997 while the results for 1998 were at a lag of less than a week. Higher significant results were detected for the daily minimum temperatures in summer 1996 compatible with the disease eruption. These findings suggest that high water temperature might have impacted the ecology of our study area and caused the emergence of the disease, as an effect of global climate change.

Barr, D.B., Bishop, A., and Needham, L.L. **Concentrations of xenobiotic chemicals in the maternal-fetal unit.** *Reproductive Toxicology* 23(3): 260-266, 2007.

Notes: Exposure to a variety of toxic chemicals has been associated with adverse health outcomes. Presumably, the most vulnerable population for these adverse health outcomes are fetuses that are exposed to toxicants *in utero*. Fetuses have immature organ systems and often their detoxification enzymes or enzymatic processes are not fully developed when exposures occur. Many xenobiotic chemicals have been shown to pass through the placental barrier and into the fetal blood stream. These exposures have been associated with adverse birth outcomes, neurocognitive delays and adult onset disease. Exposures associated with interuterine growth retardation have been linked to a variety of adult onset diseases such as coronary artery disease and diabetes. In this article, we review a variety of chemicals that have been known to enter the fetal environment and their potential to affect both early childhood and subsequently adult health. We restrict our review to chemicals shown to be present in umbilical cord blood, amniotic fluid, or meconium, thus unequivocally demonstrating the chemicals have entered the fetal environment. In some instances where known health outcomes have occurred from these exposures, we note these and any caveats associated with the exposures.

Uzumcu, M. and Zachow, R. **Developmental exposure to environmental endocrine disruptors: Consequences within the ovary and on female reproductive function.** *Reproductive Toxicology* 23(3): 337-352, 2007.

Notes: Female reproductive function depends upon the exquisite control of ovarian steroidogenesis that enables folliculogenesis, ovulation, and pregnancy. These mechanisms are set during fetal and/or neonatal development and undergo phases of differentiation throughout pre- and post-pubescent life. Ovarian development and function are collectively regulated

by a host of endogenous growth factors, cytokines, gonadotropins, and steroid hormones as well as exogenous factors such as nutrients and environmental agents. Endocrine disruptors represent one class of environmental agent that can impact female fertility by altering ovarian development and function, purportedly through estrogenic, anti-estrogenic, and/or anti-androgenic effects. This review discusses ovarian development and function and how these processes are affected by some of the known estrogenic and anti-androgenic endocrine disruptors. Recent information suggests not only that exposure to endocrine disruptors during the developmental period causes reproductive abnormalities in adult life but also that these abnormalities are transgenerational. This latter finding adds another level of importance for identifying and understanding the mechanisms of action of these agents.

Grandjean, P. **Methylmercury toxicity and functional programming.** *Reproductive Toxicology* 23(3): 414-420, 2007.

Notes: *Purpose* - Adverse health effects of developmental toxicants may induce abnormal functional programming that leads to lasting functional deficits. This notion is considered from epidemiological evidence using developmental methylmercury neurotoxicity as an example. *Most important findings* - Accumulating evidence indicates that adverse effects may occur even at low-level methylmercury exposures from seafood and freshwater fish. Neurobehavioral outcomes are usually non-specific, and imprecise exposure assessment results in a bias toward the null. Essential nutrients may promote the development of certain brain functions, thereby causing confounding bias. The functional deficits caused by prenatal methylmercury exposure appear to be permanent, and their extent may depend on the joint effect of toxicants and nutrients. *Principal conclusions* - The lasting functional changes caused by neurodevelopmental methylmercury toxicity fit into the pattern of functional programming, with effects opposite to those linked to beneficial stimuli.

Sunderland, E.M. **Mercury exposure from domestic and imported estuarine and marine fish in the US seafood market.** *Environmental Health Perspectives* 115(2): 235-242, 2007.

Notes: BACKGROUND: Methylmercury exposure causes a variety of adverse effects on human health. Per capita estimates of mercury exposure are critical for risk assessments and for developing effective risk management strategies. OBJECTIVE: This study investigated the impact of natural stochasticity in mercury concentrations among fish and shellfish harvested from the Atlantic Ocean, Pacific Ocean, and foreign shores on estimated mercury exposures. METHODS: Mercury concentrations and seafood consumption are grouped by supply region (Atlantic Ocean, Pacific Ocean, and foreign shores). Distributions of intakes from this study are compared with values obtained using national FDA (Food and Drug Administration) mercury survey data to assess the significance of geographic variability in mercury concentrations on exposure estimates. RESULTS: Per capita mercury intake rates calculated using FDA mercury data differ significantly from those based on mercury concentration data for each supply area and intakes calculated for the 90th percentile of mercury concentrations. CONCLUSIONS: Differences in reported mercury concentrations can significantly affect per capita mercury intake estimates, pointing to the importance of spatially refined mercury concentration data. This analysis shows that national exposure estimates are most influenced by reported concentrations in imported tuna, swordfish, and shrimp; Pacific pollock; and Atlantic crabs. Collecting additional mercury concentration data for these seafood categories would improve the accuracy of national exposure estimates.

Budtz-Jorgensen, E., Grandjean, P., and Weihe, P. **Separation of risks and benefits of seafood intake.** *Environmental Health Perspectives* 115(3): 323-327, 2007.

Notes: BACKGROUND: Fish and seafood provide important nutrients but may also contain toxic contaminants, such as methylmercury. Advisories against pollutants may therefore conflict with dietary recommendations. In resolving this conundrum, most epidemiologic studies provide little guidance because they address either nutrient benefits or mercury toxicity, not both. OBJECTIVES: Impact on the same health outcomes by two exposures originating from the same food source provides a classical example of confounding. To explore the extent of this bias, we applied structural equation modeling to data from a prospective study of developmental methylmercury neurotoxicity in the Faroe Islands. RESULTS: Adjustment for the benefits conferred by maternal fish intake during pregnancy resulted in an increased effect of the prenatal methylmercury exposure, as compared with the unadjusted remits. The dietary questionnaire response is likely to be an imprecise proxy for the transfer of seafood nutrients to the fetus, and this imprecision may bias the confounder-adjusted

mercury effect estimate. We explored the magnitude of this bias in sensitivity analysis assuming a range of error variances. At realistic imprecision levels, mercury-associated deficits increased by up to 2-fold when compared with the unadjusted effects. CONCLUSIONS: These results suggest that uncontrolled confounding from a beneficial parameter, and imprecision of this confounder, may cause substantial underestimation of the effects of a toxic exposure. The adverse effects of methylmercury exposure from fish and seafood are therefore likely to be underestimated by unadjusted results from observational studies, and the extent of this bias will be study dependent.

Axelrad, D.A., Bellinger, D.C., Ryan, L.M., and Woodruff, T.J. **Dose-response relationship of prenatal mercury exposure and IQ: An integrative analysis of epidemiologic data.** *Environmental Health Perspectives* 115(4): 609-615, 2007.

Notes: BACKGROUND: Prenatal exposure to mercury has been associated with adverse childhood neurologic outcomes in epidemiologic studies. Dose- response information for this relationship is useful for estimating benefits of reduced mercury exposure. OBJECTIVES: We estimated a dose-response relationship between maternal mercury body burden and subsequent childhood decrements in intelligence quotient (IQ), using a Bayesian hierarchical model to integrate data from three epidemiologic studies. METHODS: Inputs to the model consist of dose-response coefficients from studies conducted in the Faroe Islands, New Zealand, and the Seychelles Islands. IQ coefficients were available from previous work for the latter two studies, and a coefficient for the Faroe Islands study was estimated from three IQ subtests. Other tests of cognition/ achievement were included in the hierarchical model to obtain more accurate estimates of study-to-study and end point-to-end point variability. RESULTS: We find a central estimate of -0.18 IQ points (95% confidence interval, -0.378 to -0.009) for each parts per million increase of maternal hair mercury, similar to the estimates for both the Faroe Islands and Seychelles studies, and lower in magnitude than the estimate for the New Zealand study. Sensitivity analyses produce similar results, with the IQ coefficient central estimate ranging from -0.13 to -0.25. CONCLUSIONS: IQ is a useful end point for estimating neurodevelopmental effects, but may not fully represent cognitive deficits associated with mercury exposure, and does not represent deficits related to attention and motor skills. Nevertheless, the integrated IQ coefficient provides a more robust description of the dose-response relationship for prenatal mercury exposure and cognitive functioning than results of any single study,

---

Hennig, B., Ettinger, A.S., Jandacek, R.J., Koo, S., McClain, C., Seifried, H., Silverstone, A., Watkins, B., and Suk, W.A. **Using nutrition for intervention and prevention against environmental chemical toxicity and associated diseases.** *Environmental Health Perspectives* 115(4): 493-495, 2007.

Notes: BACKGROUND: Nutrition and lifestyle are well-defined modulators of chronic diseases. Poor dietary habits (such as high intake of processed foods rich in fat and low intake of fruits and vegetables), as well as a sedentary lifestyle clearly contribute to today's compromised quality of life in the United States. It is becoming increasingly clear that nutrition can modulate the toxicity of environmental pollutants. OBJECTIVES: Our goal in this commentary is to discuss the recommendation that nutrition should be considered a necessary variable in the study of human disease associated with exposure to environmental pollutants. DISCUSSION: Certain diets can contribute to compromised health by being a source of exposure to environmental toxic pollutants. Many of these pollutants are fat soluble, and thus fatty foods often contain higher levels of persistent organics than does vegetable matter. Nutrition can dictate the lipid milieu, oxidative stress, and antioxidant status within cells. The modulation of these parameters by an individual's nutritional status may have profound affects on biological processes, and in turn influence the effects of environmental pollutants to cause disease or dysfunction. For example, potential adverse health effects associated with exposure to polychlorinated biphenyls may increase as a result of ingestion of certain dietary fats, whereas ingestion of fruits and vegetables, rich in antioxidant and anti-inflammatory nutrients or bioactive compounds, may provide protection. CONCLUSIONS: We recommend that future directions in environmental health research explore this nutritional paradigm that incorporates a consideration of the relationships between nutrition and lifestyle, exposure to environmental toxicants, and disease. Nutritional interventions may provide the most sensible means to develop primary prevention strategies of diseases associated with many environmental toxic insults.

Voorspoels, S., Covaci, A., Neels, H., and Schepens, P. **Dietary PBDE intake: A market-basket study in Belgium.** *Environment International* 33(1): 93-97, 2007.

Notes: A food market-basket, representative for the general Belgian population, containing various meat, fish and dairy food products, was assembled and analysed for its polybrominated diphenyl ether (PBDE) content. Additionally, fast food samples were also investigated. Based on the measured PBDE levels, an average daily dietary intake estimate of PBDEs was calculated. Of all foods analysed, fish had the highest average sum of PBDE levels (BDEs 28, 47, 99, 100, 153, 154, and 183; 460 pg/g ww), followed by dairy products and eggs (260 pg/g ww), fast food (86 pg/g ww) and meat products (70 pg/g ww). One fresh salmon filet had the highest total concentration of PBDEs (2360 pg/g ww), whereas levels in steak and chicken breast were the lowest of all foods analysed. BDE 209 was never found above LOQ in any food. PBDE intake calculations were based on the average daily food consumption in Belgium and were estimated between 23 and 48 ng/day of total PBDEs (lower and upper bound). This value is in accordance with what was previously reported for diets from geographical distinct areas, such as Canada, Finland, Spain, Sweden and the UK. Although it is only a minor constituent of the Belgian diet, fish is the major contributor to the total daily PBDE-intake (around 40%) due to the high PBDE levels in this type of food. Although low contaminated, meat products account for around 30% of the total dietary intake of PBDEs. Dairy products and eggs contribute to a lesser degree (less than 30%).

Crespo-Lopez, M.E., de Sa, A.L., Herculano, A.M., Burbano, R.R., and do Nascimento, J.L.M. **Methylmercury genotoxicity: A novel effect in human cell lines of the central nervous system.** *Environment International* 33(2): 141-146, 2007.

Notes: Methylmercury is an important source of environmental contamination and the central nervous system (CNS) is one of the main target organs. Methylmercury genotoxicity was already demonstrated in peripherical tissues but was never detected in the brain. Thus, the objective of this work was to verify its genotoxic effect using brain cell lines. Glioblastoma (U373) and neuroblastoma (B103) human cell lines were exposed to methylmercury (0-10 μM). By measuring cellular viability, concentrations inducing < 20% of cellular death ($P < 0.05$) were selected: 1 and 0.1 μM. To detect micronuclei, 200.000 cells were treated with methylmercury for 24 h, and then incubated with cytochalasin B (2 μg/ml) for 72 h (U373) or 48 h (B103). The binucleation index, frequency of micronucleated cells, micronucleation index, metaphasic index and index of nucleoplasmic bridges were determined. Statistical analysis showed indices and percentages significantly higher ($P < 0.05$) in methylmercury-treated cells. Each cell line was shown to be differently sensitive to each biormarker of genotoxic damage, which seems to indicate the existence of different mechanisms of toxicity. This work demonstrates, for the first time, MeHg ability to provoke genotoxicity in cells of brain origin with relatively low levels of exposure.

Bocio, A., Domingo, J.L., Falco, G., and Llobet, J.M. **Concentrations of PCDD/PCDFs and PCBs in fish and seafood from the Catalan (Spain) market: Estimated human intake.** *Environment International* 33(2): 170-175, 2007.

Notes: The concentrations of polychlormated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs) and biphenyls (PCBs) in samples from 14 fish and seafood species widely consumed by the population of Catalonia, Spain, were measured. These samples were randomly purchased independently of their geographical origin. The intake of PCDD/Fs and PCBs through consumption of these species was also estimated for various age and sex groups of this population. The highest and lowest levels of PCDD/Fs and dioxin-like PCBs (DL-PCBs) were found in red mullet and shrimp, respectively. For a standard adult man (70 kg body weight), the intake of PCDD/Fs plus DL-PCBs through consumption of fish and other seafood was estimated to be 38.0 pg VMO-TEQ/day. Tuna, hake, and sardine were the species with the highest contribution to this intake. The results of this study indicate that, in general terms, the dietary habits of the population of Catalonia (Spain) regarding fish and seafood consumption do not contribute remarkably to increase PCDD/F and DL-PCB intake.

Domingo, J.L. and Bocio, A. **Levels of PCDD/PCDFs and PCBs in edible marine species and human intake: A literature review.** *Environment International* 33(3): 397-405, 2007.

Notes: Polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs) and biphenyls (PCBs) are lipophilic organic compounds whose origin comes from many different sources. PCDD/Fs and PCBs are ubiquitous and persistent environmental pollutants with a well known potential toxicity, which were included at the 1998 UN-EC POP protocol. Although human exposure to PCDD/Fs and PCBs can occur by various routes, food is the primary source. A number of studies have shown that the major food sources of these organic pollutants are fat-containing animal products, including fish

and other seafood. Because of the frequent health recommendations concerning fish consumption, to determine the contribution to the dietary intake of chemical contaminants such as PCDD/Fs and PCBs through fish and other seafood consumption is an issue of special interest. This paper reviews the state of the science regarding recent literature on PCDD/F and PCB levels in marine species and human intake through fish and seafood consumption. The concentrations of these pollutants depend basically on the environment in which the respective species are caught. It is concluded that some groups of population frequently consuming high quantities of certain species could be significantly increasing health risks due to PCDD/F and PCB exposure.

Albinana-Gimenez, N., Clemente-Casares, P., Bofill-Mas, S., Hundesa, A., Ribas, F., and Girones, R. **Distribution of human polyomaviruses, adenoviruses, and hepatitis E virus in the environment and in a drinking-water treatment plant.** *Environmental Science and Technology* 40(23): 7416-7422, 2006.

Notes: Large numbers of viruses are excreted in human feces and urine, which even at low concentrations may cause illness when ingested. Some of these viruses have not been traditionally monitored in terms of waterborne diseases and are considered emergent viruses, such as hepatitis E virus (HEV) and JC and BK polyomavirus (JCPyV and BKPyV). The high prevalence of human adenoviruses (HAdV) and polyomaviruses, which both show DNA genomes, in sewage from widely divergent areas has suggested the relevance of evaluating these viruses as possible indicators of viral contamination. The concentration of these viruses was analyzed in sewage and river water and after treatment in a drinking-water treatment plant including chlorination, flocculation, ozonation, and granulate active carbon (GAC) filtration. Samples of GAC-filtered water were collected before a second chlorination treatment. The river used as a source of fresh water presented an average concentration of 2.6 x 10^1 JCPyV and 4 x 10^2 HAdV GC (genome copies)/L. A removal of 2 logarithms (99%) of HAdV and JCPyV was observed in the drinking-water treatment plant. All the GAC-filtered water samples studied contained HAdV, with a mean value of 4.3 HAdV GC/L. HEV strains belonging to genotype 3 were frequently detected in low concentrations in urban sewage and in biosolids or sewage containing swine feces but not in the river water samples studied. The detection of viruses by molecular techniques is useful for genetically describe emergent viruses in community wastewaters and water supplies. Quantification of JCPyV and HAdV using quantitative real-time PCR (QPCR) may be useful for evaluating virus removal efficiency in water treatment plants and as an index of the virological quality of water and of the potential presence of human viruses.

Abulreesh, H.H., Paget, T.A., and Goulder, R. **Campylobacter in waterfowl and aquatic environments: Incidence and methods of detection.** *Environmental Science and Technology* 40(23): 7122-7131, 2006.

Notes: Campylobacters are emerging as one of the most significant causes of human infections worldwide, and the role that waterfowl and the aquatic environment have in the spread of disease is beginning to be elucidated. On a world scale campylobacters are possibly the major cause of gastrointestinal infections. Campylobacters are common commensals in the intestinal tract of many species of wild birds, including waterfowl. They are also widely distributed in aquatic environments where their origins may include waterfowl as well as sewage effluents and agricultural runoff. Campylobacters have marked seasonal trends. In temperate aquatic environments they peak during winter, whereas spring-summer is the peak period for human infection. Campylobacter species may survive, and remain potentially pathogenic, for long periods in aquatic environments. The utility of bacterial fecal indicators in predicting the presence of campylobacters in natural waters is questionable. Viable but nonculturable *Campylobacter* cells may occur, but whether they have any role in the generation of outbreaks of campylobacteriosis is unclear. The routine detection of *Campylobacter* spp. in avian feces and environmental waters largely relies on conventional culture methods, while the recognition of a particular species or strain is based on serotyping and increasingly on molecular methods. Thus, PCR combined with selective enrichment enhances the detection of campylobacters in water and feces, while DNA sequencing facilitates recognition of particular species and strains.

Jiang, S.C. **Human adenoviruses in water: Occurrence and health implications: A critical review.** *Environmental Science and Technology* 40(23): 7132-7140, 2006.

Notes: Adenoviruses are important human pathogens that are responsible for both enteric illnesses and respiratory and eye infections. Recently, these viruses have been found to be prevalent in rivers, coastal waters, swimming pool waters, and

drinking water supplies worldwide. United Sates Environmental Protection Agency (USEPA) listed adenovirus as one of nine microorganisms on the Contamination Candidate List for drinking water because their survival characteristic during water treatment is not yet fully understood. Adenoviruses have been found to be significantly more stable than fecal indicator bacteria and other enteric viruses during UV treatment. Adenovirus infection may be caused by consumption of contaminated water or inhalation of aerosolized droplets during water recreation. The goal of this review is to summarize the state of technology for adenovirus detection in natural and drinking waters and the human health risk imposed by this emerging pathogen. The occurrence of these viruses in natural and treated waters is summarized from worldwide reports.

Muniesa, M., Jofre, J., Garcia-Aljaro, C., and Blanch, A.R. **Occurrence of *Escherichia coli* 0157: H7 and other enterohemorrhagic *Escherichia coli* in the environment.** *Environmental Science and Technology* 40(23): 7141-7149, 2006.

Notes: Enterohemorrhagic *Escherichia coli* (EHEC) (O157 and other serotypes) are zoonotic pathogens linked with severe human illnesses. The main virulence factors of EHEC are the Shiga toxins, among others. Most of the genes coding for these toxins are bacteriophage-encoded. Although ruminants are recognized as their main natural reservoir, water has also been documented as a way of transmission of EHEC. *E. coli* O157:H7 and other EHEC may contaminate waters (recreational, drinking or irrigation waters) through feces from humans and other animals. Indeed, the occurrence of EHEC carrying the *stx*(2) gene in raw municipal sewage and animal wastewater from several origins has been widely documented. However, the evaluation of the persistence of naturally occurring EHEC in the environment is still difficult due to methodological problems. Methods proposed for the detection and isolation of *stx*-encoding bacteria, ranging from the classic culture-based methods to molecular approaches, and their application in the environment, are discussed here. Most virulence factors associated with these strains are linked to either plasmids or phages, and consequently they are likely to be subject to horizontal gene transfer between species or serotypes. Moreover, the presence of infectious *stx*-phages isolated as free particles in the environment and their high persistence in water systems suggest that they may contribute to the spread of *stx* genes, as they are directly involved in the emergence of new pathogenic strains, which might have important health consequences.
